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MERCURY VAPOR LAMP CONNECTOR CONSTRUCTION
AND STARTING CIRCUIT THEREFOR

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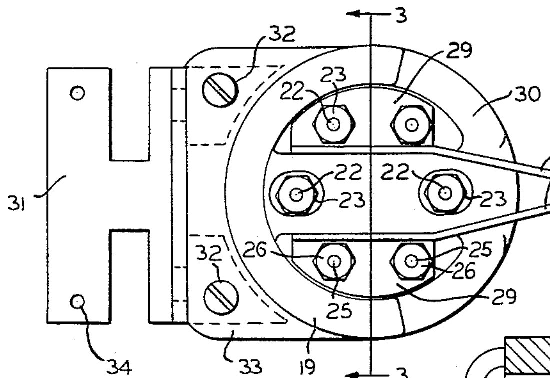

Fig. 2

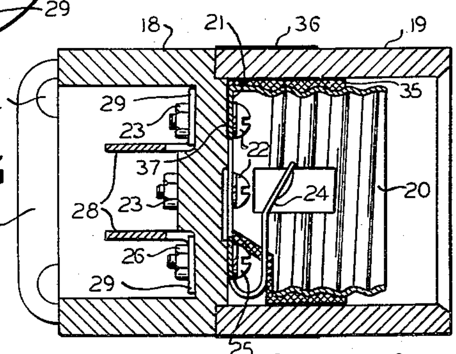

Fig. 3

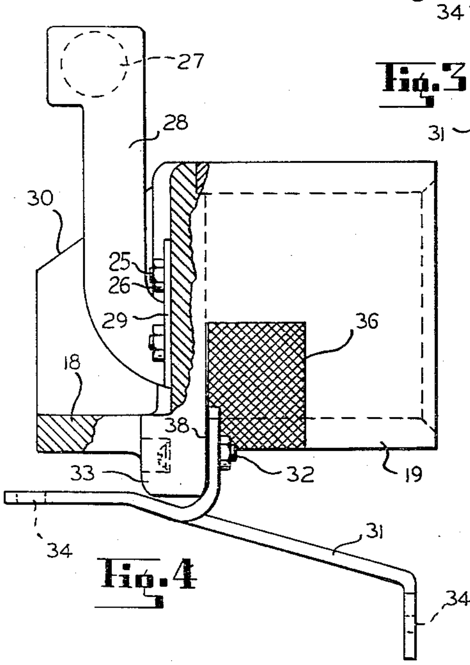

Fig. 4

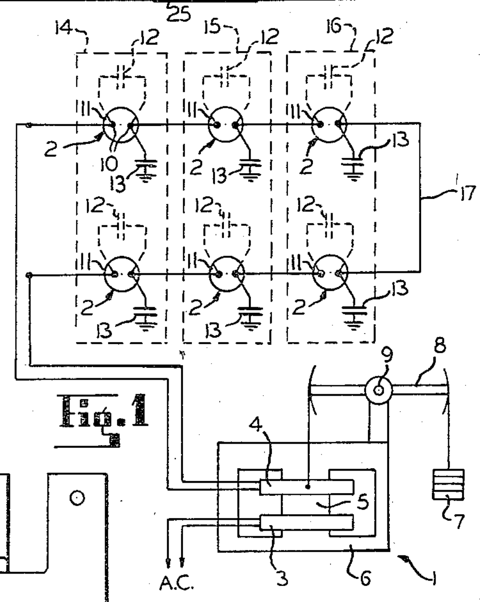

Fig. 1

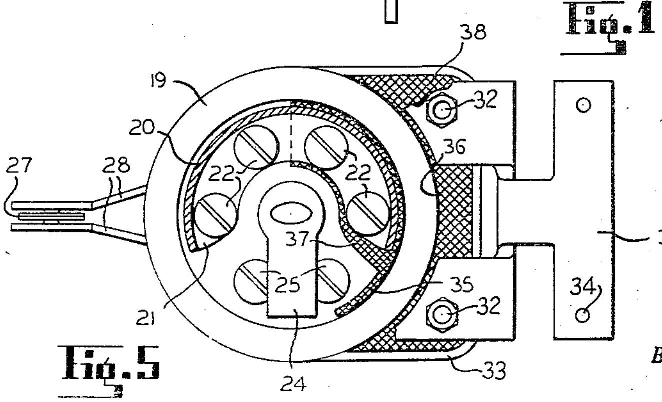

Fig. 5

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MERCURY VAPOR LAMP CONNECTOR CONSTRUCTION AND STARTING CIRCUIT THEREFOR

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This invention relates to an improved mercury vapor lamp connector construction and a novel starting circuit for series connected vapor lamps.

Incandescent lamp systems for street lighting and other lighting applications are being rapidly replaced with mercury vapor lamp systems. In both systems the lamps are normally connected in a series circuit and operated from a constant current source.

The characteristic of a mercury vapor lamp is such that a substantially higher voltage is necessary to start the lamp than is necessary to maintain the lamp in operation. When a number of lamps are connected in series, the required starting voltage is therefore quite high.

A common power source presently in use in lighting systems is the conventional moving or floating coil constant current regulator. This type of regulator is normally rated at maximum voltage output and therefore when employed with mercury vapor lamps it is necessarily operated at substantially less than full rating because the full rating is necessary to initially start the lamp circuit.

Although static type regulators have been designed for mercury vapor lamp circuits, they are of a special construction. Further, to replace the present moving coil units would normally be too expensive to be practical. The moving coil also has other advantages, such as, it is relatively inexpensive and its current output is only a function of the coil turns and the balancing weight and therefore compensates for line voltage fluctuation. In the static type units, the current output is a function of the voltage input and varies with line voltage fluctuations.

In accordance with the present invention a shunt path having relatively low capacitive reactance or impedance is connected in circuit with one or more but less than all of the lamps in the circuit. This added capacitive shunt in combination with the inherent capacity in the mercury vapor lamp forms a voltage dividing network. At the instant of starting, the voltage dividing network establishes an auxiliary starting circuit with the voltage of the source appearing practically entirely across the high capacitive impedance vapor lamps. The lamps are then fired and the source voltage less the operating voltage of the fired lamps appears across the high capacitive shunt. This voltage starts the next bank of lamps connected through a similar capacitive shunt path. Thus, in effect, a series of cascaded parallel circuits comprising one or more of the lamps in the operating circuit is progressively provided with the source voltage less the operating voltage of the fired lamps. The voltage source therefore need only be sufficiently large to provide the total operating voltage plus the slight additional required for the lamps in any one shunt path.

Further, in accordance with the present invention, the conventional insulating material in a mercury vapor lamp socket is preferably metallized to form a capacitor as an integral part of the lamp socket.

The accompanying drawing illustrates the best mode presently contemplated by the inventor for carrying out the invention.

In the drawing:

Figure 1 is a schematic circuit of a mercury vapor lamp system;

Fig. 2 is an elevational view of a mercury vapor lamp socket;

Fig. 3 is a view taken on line 3—3 of Fig. 2;

Fig. 4 is a side elevational view of the lamp socket with parts broken away to more clearly show certain details of the socket; and

Fig. 5 is an elevational view looking into the socket shell.

Referring to the drawings and particularly Figure 1; a current regulator **1** of the movable coil type is connected to furnish current to a plurality of mercury vapor lamps **2** which are connected in a series lighting circuit. The regulator **1** is adapted to furnish a constant current to maintain the operation of the lamps **2**.

The regulator **1** is a conventional type employing a primary winding **3** and a moving secondary coil or winding **4** both wound on the central leg **5** of a three-legged core **6**. A counterweight **7** is connected to one end of an arm **8** and the secondary coil **4** is connected to the opposite end of arm **8** which is centrally pivoted as at **9**. The weight **7** is slightly less than the weight of the secondary winding **4** and biases the winding **4** upwardly away from the primary coil **3** such that small force can move the secondary winding. The regulator **1** functions in a conventional manner with the secondary coil **4** normally adjacent the primary coil **3** until current is to be drawn. When current is drawn from the secondary coil **4**, a magnetic repulsion between the two coils is established and separates them with the weight of the secondary coil **4** balanced by the sum of the repulsion force plus the weight **7**. If any change in the secondary current occurs, the repulsion force between the two windings **3** and **4** changes accordingly and the coupling of the windings **3** and **4** changes to re-establish the predetermined current.

The mercury vapor lamps **2** are connected in a series circuit across the secondary winding **4** with the weight **7** selected to maintain a suitable constant current output.

As schematically shown in Figure 1, each mercury vapor lamp **2** includes a pair of electrodes **10** disposed within an envelope **11** containing a small quantity of mercury, not shown, which, during operation, vaporizes and serves as the conducting medium.

There is an inherent capacity within each lamp which is in shunt with the electrodes **10** and is represented in Figure 1 by the dotted lines **12**. This inherent capacity arises due to the spaced electrodes and, when present, the conventional film cutout, not shown in Figure 1. The total capacity of a lamp is generally quite low with 20 micromicrofarads per lamp being typical of mercury vapor street lamps.

In accordance with the present invention, a relatively large capacitor **13** is connected to each lamp electrode **10** most removed from the secondary winding **4** and to ground. With six lamps, as shown in Figure 1, it will be seen that the lamps **2** are effectively paired off in a number of parallel starting circuits with the first two lamps **2** connected directly across the secondary winding through the associated capacitors **13** to form a first starting circuit as shown within the dotted lines **14**. When the regulator **1** is first energized, the open circuit voltage of the secondary **4** appears across this first starting circuit **14**. As the shunting capacitors **13** have a relatively high capacitance with respect to the inherent capacity of the mercury vapor lamps, practically the entire open circuit voltage appears across the first two mercury vapor lamps. The two lamps **2** ignite and the lamp operating voltage then appears across the lamps and the open circuit voltage of the regulator **1** minus the operating voltage of the first two lamps appears across the first pair of the shunt capacitors **13** of the first starting circuit **14**.

The next pair of lamps **2** is connected in a starting circuit serially including a pair of shunt capacitors **13** as shown within the dotted lines **15**, with the circuit connected across the first pair of shunt capacitors. The voltage across the first two shunt capacitors **13** divides between the second pair of mercury vapor lamps **2** and the second pair of shunt capacitors **13** within the dotted lines **15**. As in the first instance, practically the entire available voltage across the first pair of shunt capacitors appears across the low inherent capacity of the mercury vapor lamps **2** which therefore ignite. The open circuit voltage of the regulator **1** less the operating voltage of the four ignited lamps then appears across the latter pair of shunt capacitors **13**. This net voltage is applied to a final starting circuit including the last pair of lamps **2** also having the serially connected shunt capacitors **13**, as shown within the dotted lines **16**.

A line **17** directly connecting the last pair of lamps **2** ties together the last pair of capacitors **13** and therefore they are ineffective in the illustrated circuit. The last pair of capacitors **13** is nevertheless illustrated in Fig. 1 because the specific lamp socket hereinafter described has the capacitor **13** as a unitary part of the lamp socket.

Thus, the regulator voltage cascades down the parallel or shunt starting circuits with the voltage decreasing in each case by the operating voltage of the lamps previously ignited. In the embodiment shown, the open circuit voltage of the current regulator **1** need be only sufficiently large to provide the operating voltage of all lamps plus the starting voltage for the lamps connected in any one parallel starting circuit, in this instance, the starting voltage of two lamps **2**.

However, if the total lamps in the circuit is an odd number and the lamps are paired off with one lamp in the final starting circuit, then the open circuit voltage need only be sufficiently large to provide the operating voltage of all lamps plus the starting voltage for the final lamp.

Although entirely separate capacitors **13** may be employed, it has been found particularly advantageous to incorporate the capacitance into the lamp socket, a preferred embodiment being as follows:

Referring to the drawings and particularly Fig. 3, a mercury vapor lamp socket is shown comprising a cup-shaped support **18** having a tubular member **19** secured to the bottom of the support **18**. Both the support **18** and the member **19** are formed from a high grade ceramic such as steatite to insulate the various socket components from each other and foreign objects. A threaded socket shell **20** is secured to the bottom of support **18** within the member **19** and is adapted to receive a correspondingly threaded base of a mercury vapor lamp, not shown. Referring in particular to Fig. 5, the socket shell **20** has a radially extending flange **21** which is integrally formed with the shell wall and extends roughly around three-quarters of the shell. The flange **21** is disposed immediately adjacent the support **18**, and contact mounting bolts **22** extend through the flange **21** and the base of the support **18** and receive suitable nuts **23**. The mounting bolts **22** and nuts **23** mechanically hold the socket shell **21** and also provide terminal means for connecting the shell **21** to a line contact or connector, not shown. A conventional hairpin contact clip **24** is disposed within the socket **20** and is secured to the support **18** within the free area between the ends of the flange **21**. The clip **24** is secured to the base by small mounting bolts **25** which extend through aligned openings in the base leg of the clip and the base portion of the socket and receive correspondingly threaded nuts **26**. The bolts **25** and nuts **26** clamp the clip **24** to the base **18** and also provide means for connecting the clip to a line connector, not shown.

A film cutout **27** is connected in shunt with the lamp, not shown in Figs. 2–5, by a pair of spaced conducting arms **28** and maintains the operation of the other lamps if the associated lamp goes out. The arms **28** are each provided with a flange **29** which is secured to the base and the arms **28** extend outwardly therefrom through an opening **30** in the wall, as shown in Figs. 2 and 4. The flanges **29** are connected one to the socket shell **20** and one to the contact clip **24** by the respective mounting bolts **22** and **25** to rigidly support the film cutout **27** in shunt with the lamp, not shown.

A metal mounting bracket **31** is bolted as by bolts **32** or otherwise secured to a flange **33** extending from the base portion of the cup-shaped support **18**. Bracket **31** is provided with suitable openings **34** for mounting the lamp socket in place. The socket is normally grounded by connecting the mounting bracket **31** to ground.

In accordance with the present invention, the high capacitor **13**, shown in Figure 1, is formed by superposed metal coatings **35** and **36** disposed on the inner and outer wall surfaces of the tubular socket member **19** in any suitable manner, for example, by spraying the coating onto the socket. The coatings **35** and **36** are the plates of the capacitor **13** and are generally in the form of rectangular strips encircling the member **19** to provide sufficient capacitor area. To provide for connection of the capacitor in an operating circuit, the inner coating **35** extends beneath the flange **21** of the socket shell **20** as at **37** and the outer coating **36** extends beneath the mounting bracket **31** as at **38**.

The high grade ceramic of which member **19** is normally formed is a type having a high dielectric constant, such as a titanate steatite, and therefore with a suitable plate area, a capacitor **13** having a relatively high capacitance is formed.

To provide a sufficiently high plate area, the metal coating **36** encircles the outer surface of the socket **19** adjacent the mounting bracket **31**. The inner coating **35** must cover the corresponding inner surface of the socket **19** which in the embodiment shown extends around behind the electrode contact **24**. The radial extension **37** of the inner coating **35** onto the base stops immediately adjacent the outer edge of the shell flange **21** and therefore in spaced relation to the contact **24** to prevent shorting of the lamp contacts, as shown in Fig. 5.

When the socket is connected in the circuit of Figure 1, the contact clip **24** is connected to the regulator **1** or to the adjacent lamp nearest to the current source and the socket shell **20** is connected to the next lamp. With the mounting bracket **31** grounded, the capacitor plate **36** is automatically grounded and the circuit of Figure 1 is formed without special field or separate connection of the starting capacitors **13** to the lamp socket.

As previously described, steatite is a normal insulating material for the tubular member **19** although any other suitable high dielectric constant material can be used. One type of steatite used is titanate steatite which provides a capacitance of the order of 5000 micromicrofarads in a normal lamp socket assembly. Assuming the inherent capacitance of the lamp is 20 micromicrofarads, which is previously given as a typical value, the ratio of capacitance is 250 to 1. As the voltage across the capacitive elements divides inversely with the capacitance of the elements, practically the entire starting voltage first appears across the lamps **2** in the starting circuit within the dotted lines **14** and then cascades down the other parallel starting circuits **15** and **16**, as previously described with respect to Figure 1.

If the connection of the lamp sockets in the lighting circuit is reversed, the circuit still functions in the same general manner with the built-in capacitors of each socket providing a shunt path for the preceding lamps. Although the last lamps in the series are not provided with a capacitive shunt path, this shunt path is unnecessary and therefore the lamps ignite in the same manner as previously discussed.

Further, as the total voltage of the source is equal to at least the operating voltage of all lamps plus the additional starting voltage for the lamps in the end starting circuit, the voltage applied to the initial starting circuits is substantially in excess of that applied to the final starting circuit. Therefore, the initial starting circuits may include a greater number of lamps than the subsequent circuits for a given voltage source.

The present invention provides an improved starting circuit for mercury vapor lamp circuits and a mercury vapor lamp socket having the necessary electrical components incorporated within the socket.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. A vapor lamp socket having insulating components and spaced input and output terminal components adapted to be connected in a series operating circuit and a shunt starting circuit, which comprises an insulating member having a high dielectric constant characteristic and being integrally formed with the insulating components of the socket and constituting a supporting structure for the lamp, conducting members secured to opposed aligned surfaces of the insulating member to form a capacitor, means to connect one of the conducting members to one of said terminals, and means adapted to connect the other of said conducting members in circuit with the current source to provide a shunt circuit with respect to said series operating circuit.

2. A vapor lamp connector having an insulating support with a tubular portion within which a conducting lamp socket is mounted on the support, a metallized film disposed on the inner wall of the tubular portion and extending over the support into electrical connection with one terminal of the lamp socket, a metallized film disposed on the outer surface of the tubular portion in superposed relation to said metallized film on the inner wall to form a capacitor, and means connected to the metallized film on the outer surface to permit connection to an operating power source in an auxiliary starting circuit.

3. A vapor lamp connector, which comprises a flat base portion formed of electrically insulating material, a threaded tubular metal socket adapted to receive a correspondingly threaded lamp base and having an arcuate radially inwardly extending flange, means to secure the flange to the base, a contact mounted within the socket and on the base between the ends of the arcuate flange, a tubular insulating member secured to the base circumjacent the socket to insulate the tubular socket and the contact from surrounding components, said member being formed of a high dielectric constant material, an insulating mounting flange extending from the base portion laterally of said tubular member, a metal mounting bracket secured to said mounting flange and adapted to be connected to ground, a metal film secured to the inner wall of the tube member and extended inwardly over the base portion beneath the flange of the metal socket, and a metal film secured to the outer wall of the tube member and superposed with said first metal film to form a capacitor, said last named metal film extending outwardly over the flange and beneath the mounting bracket to automatically ground the second-named metal film with the lamp connector in a mounted position.

4. A mercury vapor lamp support, which comprises a generally tubular member having an intermediate transverse wall dividing the member into a pair of cylindrical recesses and being formed of a ceramic having a high dielectric constant, a threaded metal tube concentrically disposed within one of said recesses and spaced from the walls of the tubular member and adapted to receive a correspondingly threaded lamp base, a radially inwardly extending arcuate metal flange on said tube, mounting and circuit connecting means securing the flange to the intermediate wall, a contact clip disposed within the recess accommodating the metal tube mounting and circuit connecting means securing the contact clip to the intermediate wall in spaced relation to said metal tube and said metal flange, an insulating flange laterally extending from said tubular member, a metal mounting bracket having a strap like flange secured to the insulating flange and adapted to be connected to ground in a lighting circuit, a continuous metal coating on an arcuate portion of the inner wall of the base receiving recess and on the adjacent intermediate wall carrying said flange, and a continuous metal coating on the outer wall of the tubular member superposed on the inner wall coating and extending over the flange carrying said mounting bracket, said metal coatings forming a shunt capacitive reactance to ground with the lamp support mounted and connected in a series lighting circuit.

5. In a mercury vapor lamp socket adapted to connect a lamp in a series operating circuit with other lamps and having a tubular insulating member of a high dielectric constant ceramic material forming a lamp socket and connection means, a conducting strip secured to the outer wall surface of said member, a similar conducting strip secured to the inner wall surface of said member in superposed relation to said first conducting strip to form a capacitor having a large capacitance, means to connect the second named conducting strip directly to one of the socket contacts, and means to connect the first named conducting strip to a current source to provide a series circuit including the lamp and said capacitor independently of at least one of the other lamps in said series operating circuit.

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